Prospect for Si sensors in Korea

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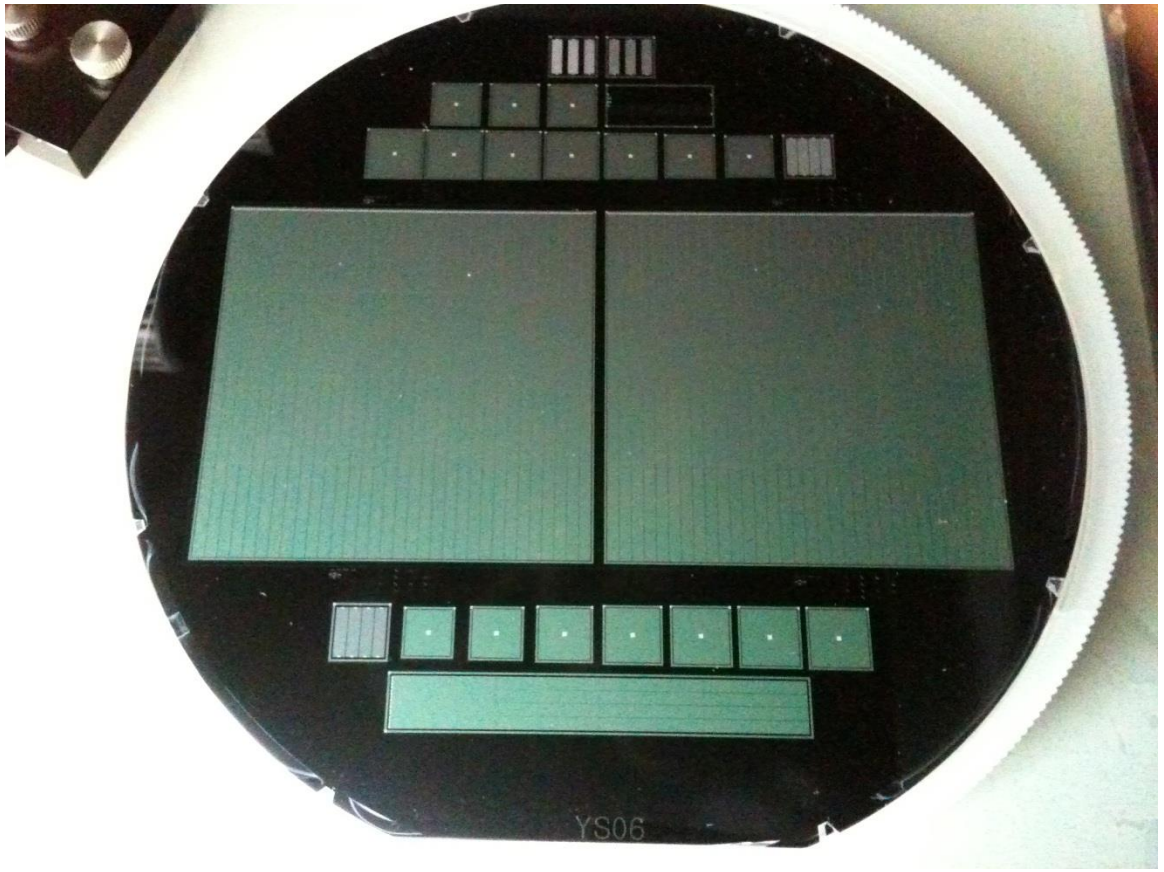
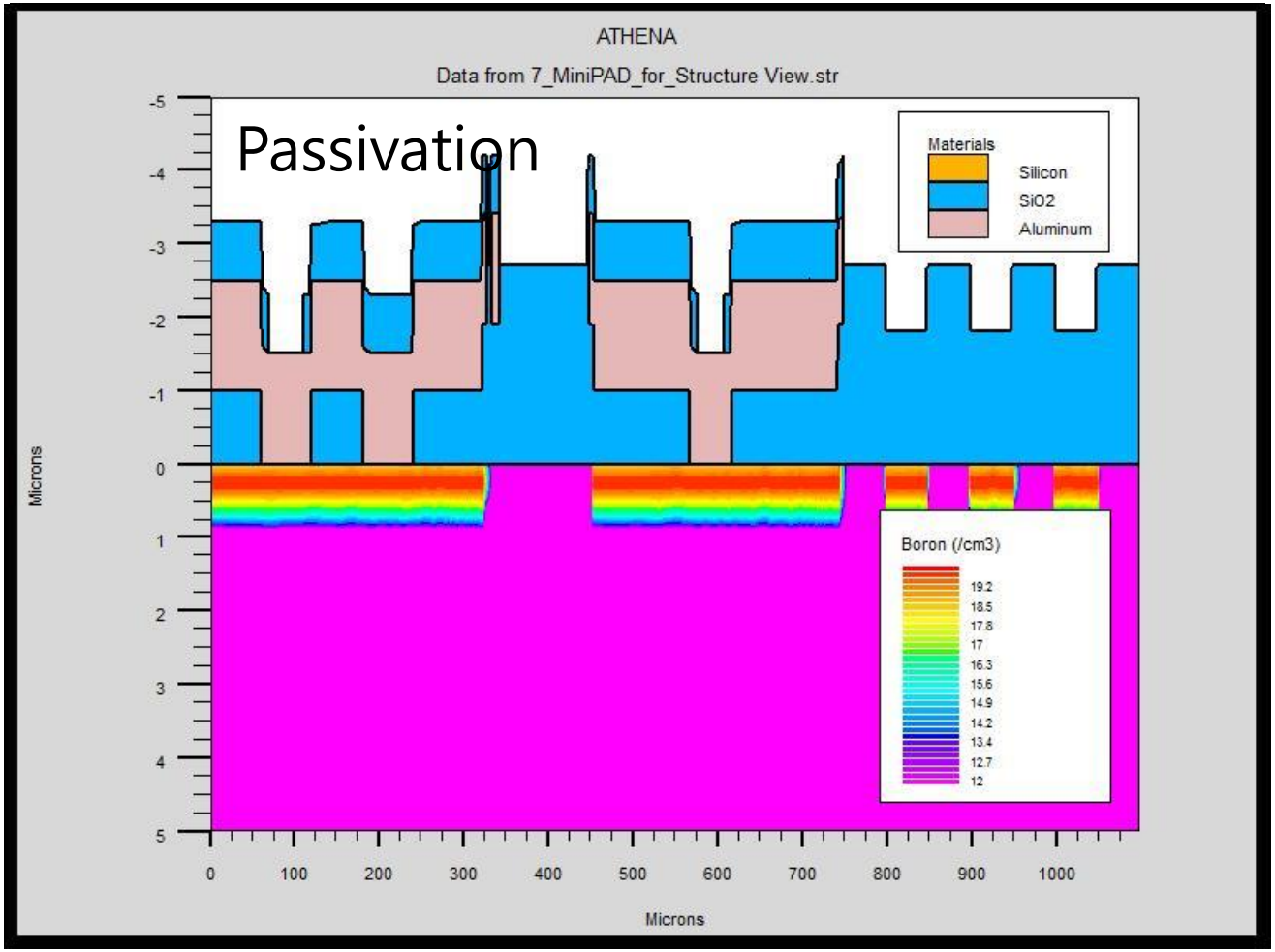
What is Si sensor? (Sensor on Si wafer)



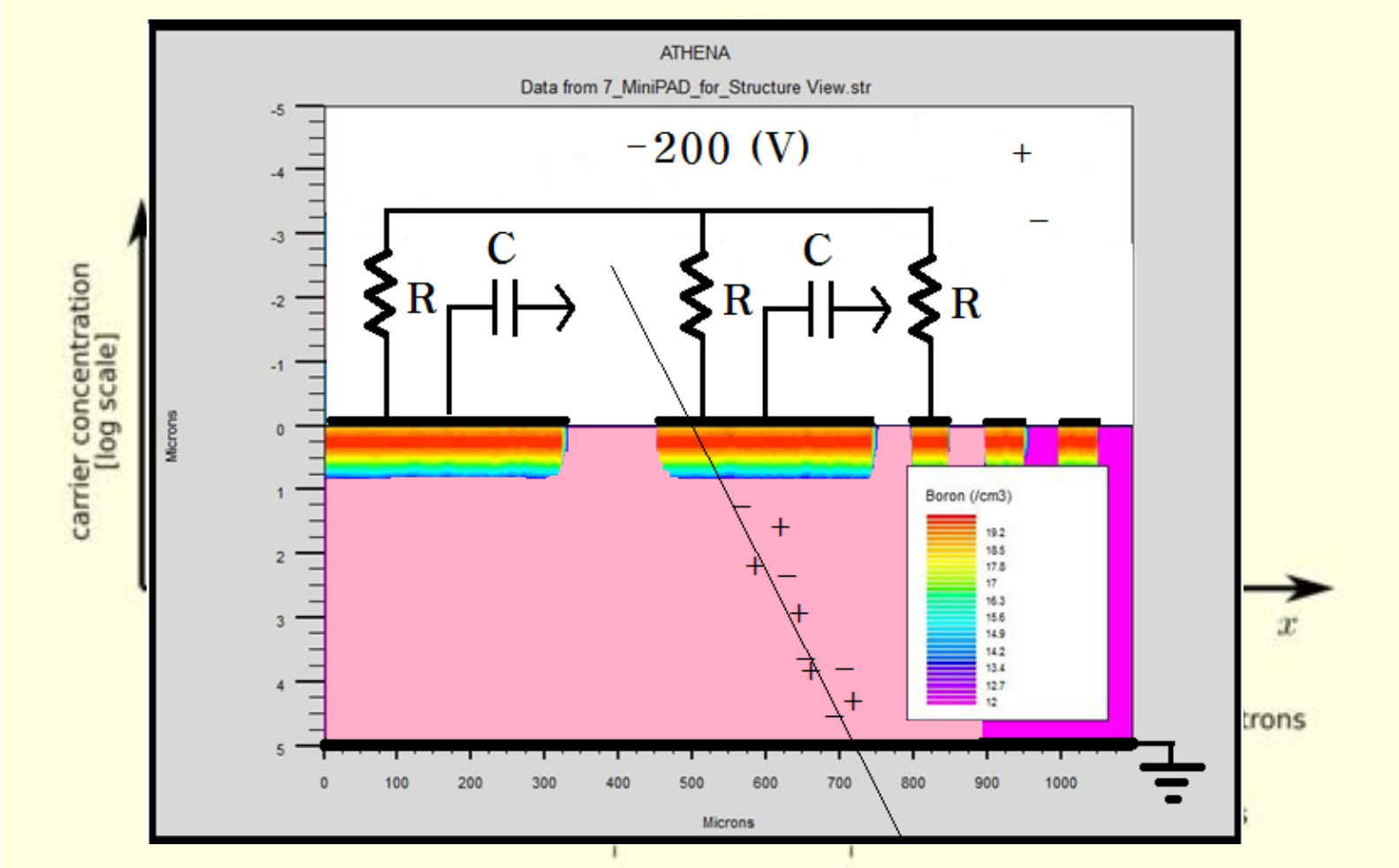
What is Si sensor? (Diced sensor)

Introduction for student

How do we make it? (CMOS process)

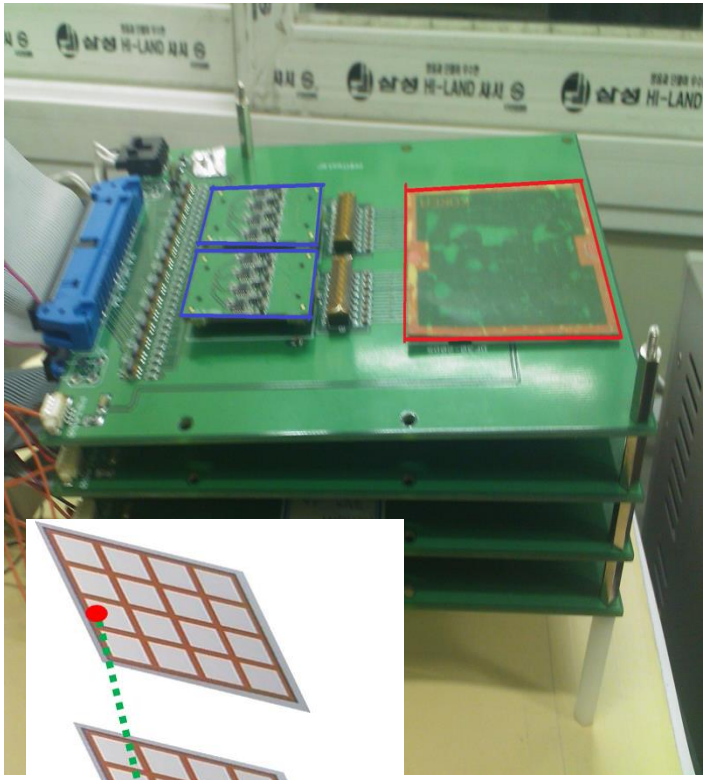


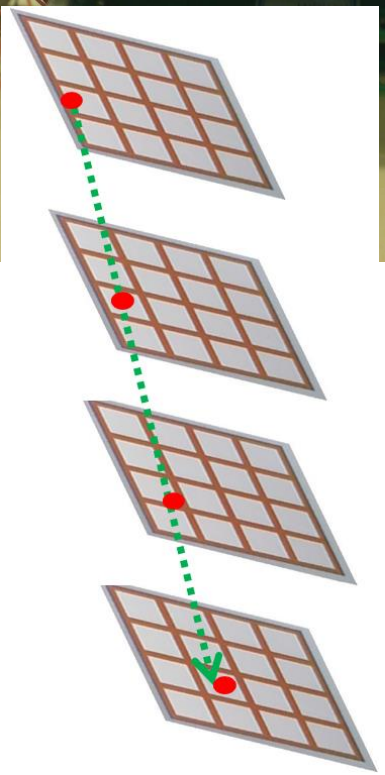
How does it operate?

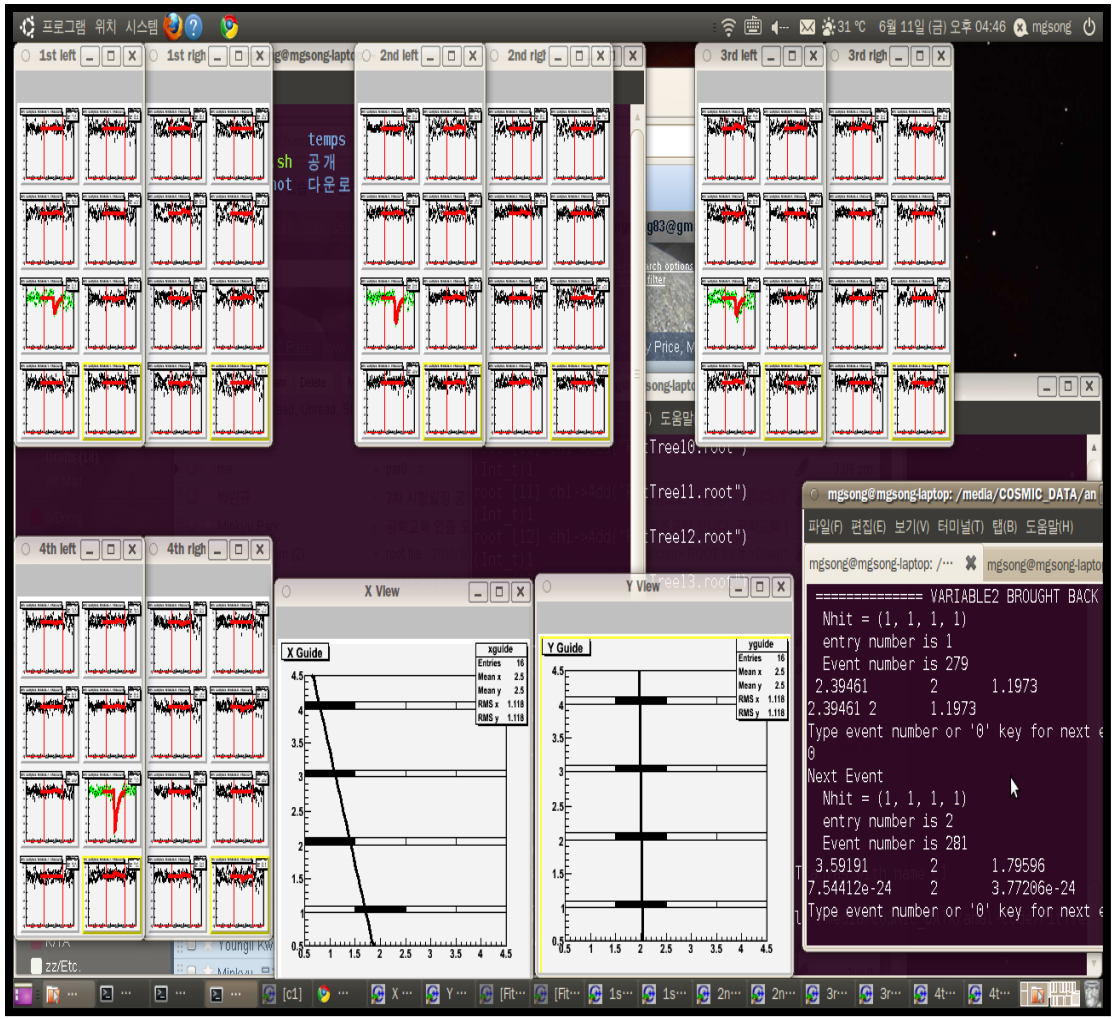


$$W = \sqrt{2\rho\mu\varepsilon\left(V + V_{bi}\right)}$$

Cosmic muon test







Possibility in Korea

Si sensor in general

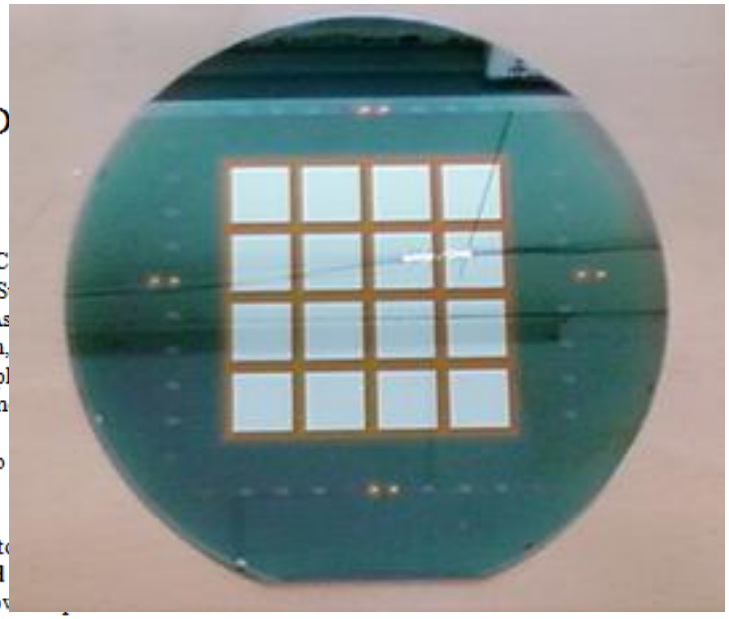
- Mature technology
- Reliable performance
- Fine granule
- Higher energy and time resolution (than gaseous ionization detectors)
- Key burden is cost.

Korean Strength

- Productivity!
  - **Large amount of Si sensors** produced with the **standard CMOS process**

R&D environment

6 inch fabrication line



300 cm^2 ~ $ 500

8 inch fabrication line

MEMORAND

(1) Youngil Kwon, Mann-Ho C
(2) Edward Kistenev, Andrey S
(3) John Lajoie, Physics and As
(4) Yongsun Yoon, BT division,
(5) Kwun-bum Chung, Elecropl
(6) Zheng Li, SDDPL, Instrum

(7) Jinsoo Kim, National Nano

I. Purpose & Scope

The purpose of this MOU is t
the '**Radiation damage and**
planning to contribute their ov
studies. This MOU clarifies the areas of pa rties will
collaborate by sharing their expertise and se ticipating
parties for the stated academic goal.

II. Responsibilities Under this MOU

A. Dr. E. Kistenev, and Prof. J. Lajoie, and Prof. Y. Kwon will propose silicon semiconductor detectors/devices to achieve academic goals in their field of interest in the experimental nuclear and high energy physics.

B. Dr. Z. Li will design the proposed silicon semiconductor detectors/devices using standards approved by industry for large area radiation hard Si devices and will advice on the radiation induced defects in Si devices.

C. Dr. A. Sukhanov will advice on the electronic design and implementation of the readout electronics for silicon semiconductor device testing.

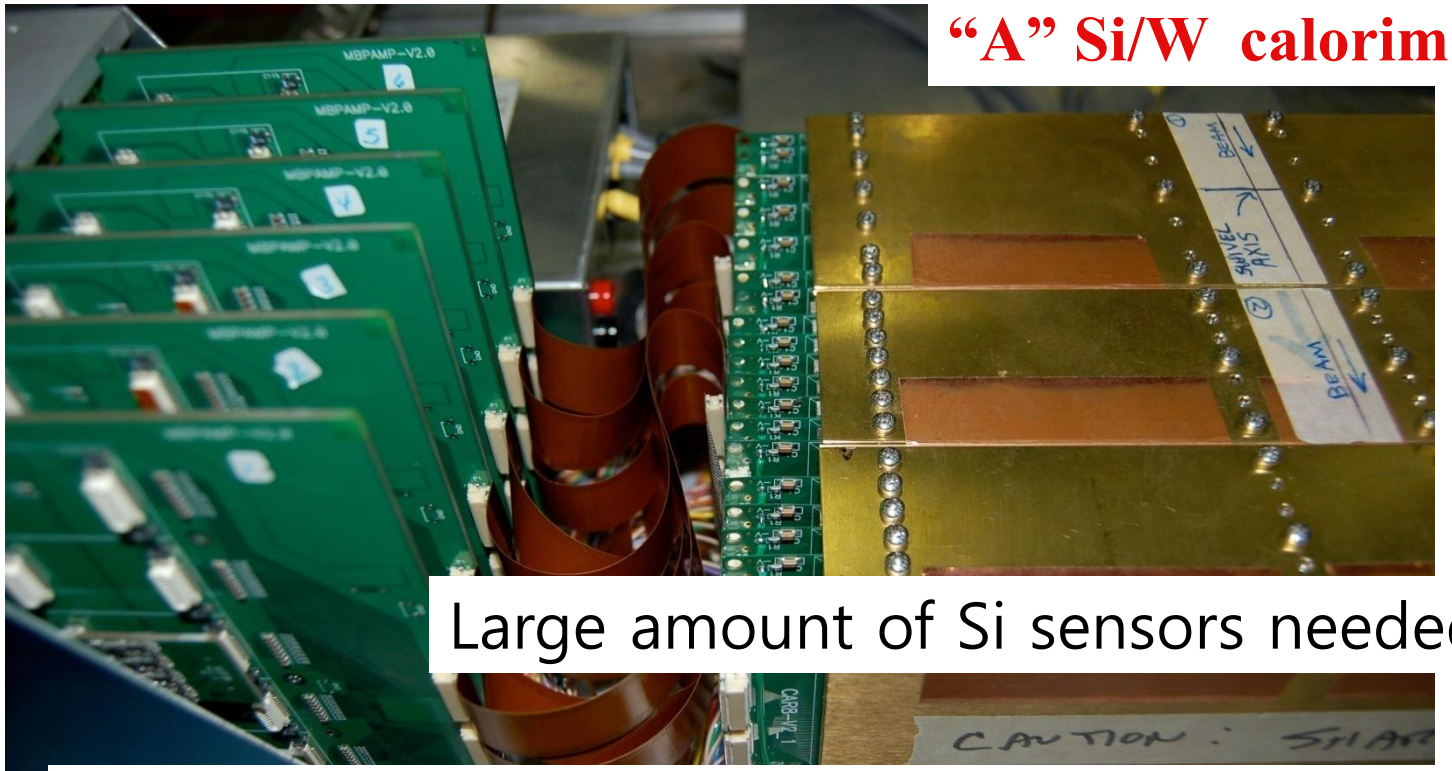
D. Dr. Yoon will inspect designs of the proposed detectors/devices and advise on matching design ideas to fabrication technologies. He will also perform his own radiation hardness testing of the devices he develops.

E. Prof. M.-H. Cho, Prof. G. T. Park, and Prof. K. B. Chung will advise on possible defects in silicon sensors/devices and will study radiation defects in the produced sensors/devices exposed to different kinds of radiation.

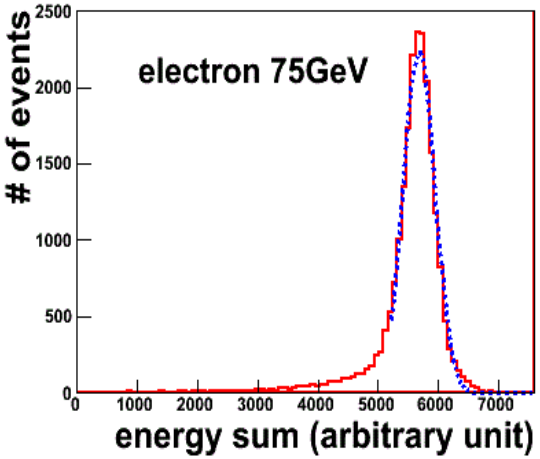
F. Mr. Kim, leader of nano patterning process team in National Nanofab Center, will assist in fabrication of the silicon sensors/devices with university discount program and consult on details of silicon detector/device fabrication process.

Application

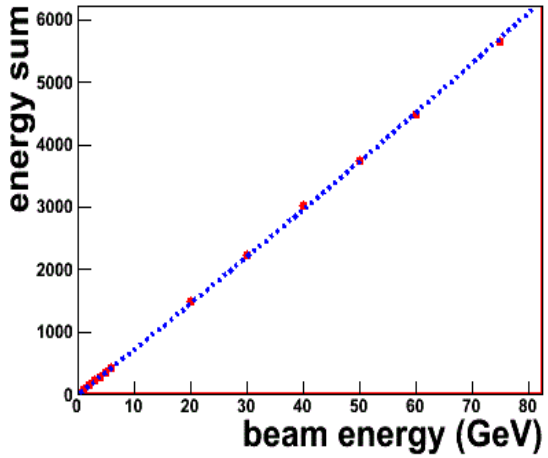
“A” Si/W calorimeter prototype



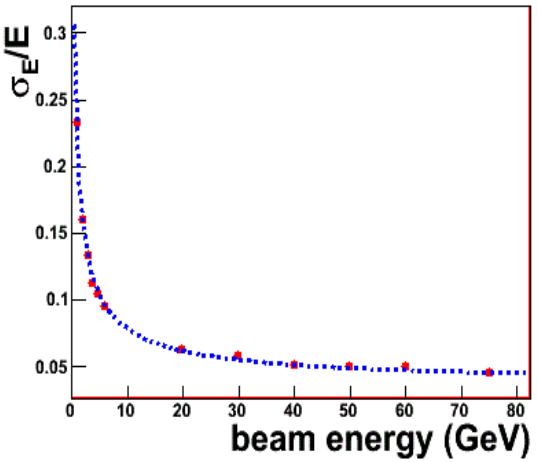
Large amount of Si sensors needed!



(a)

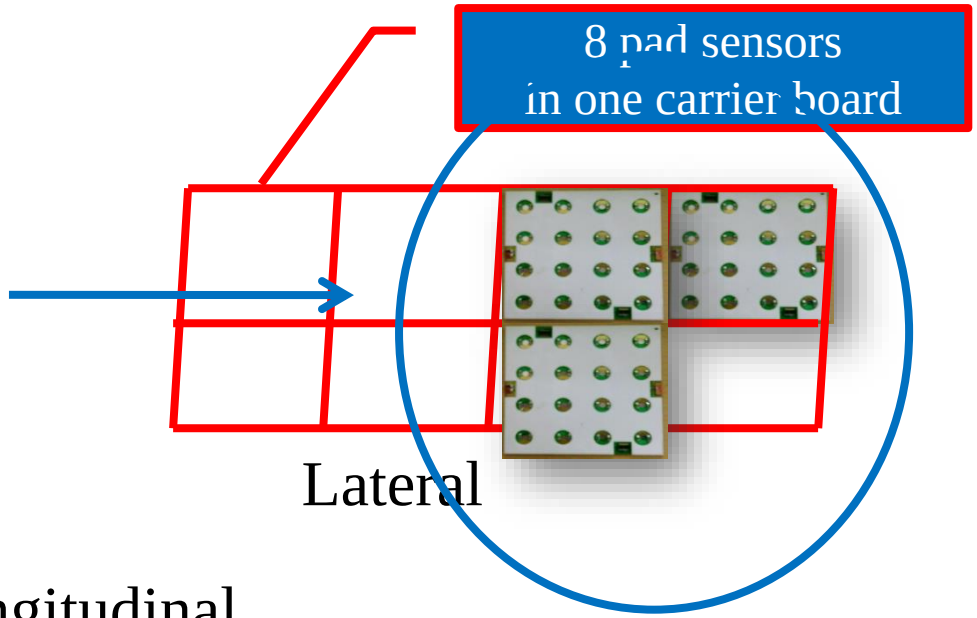


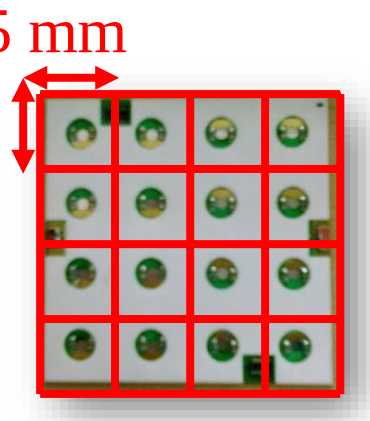
(b)



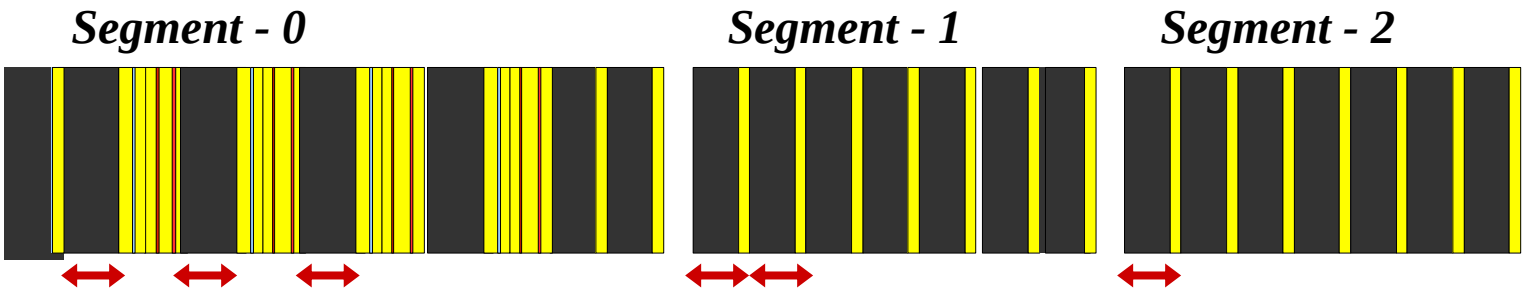
(c)

Schematics

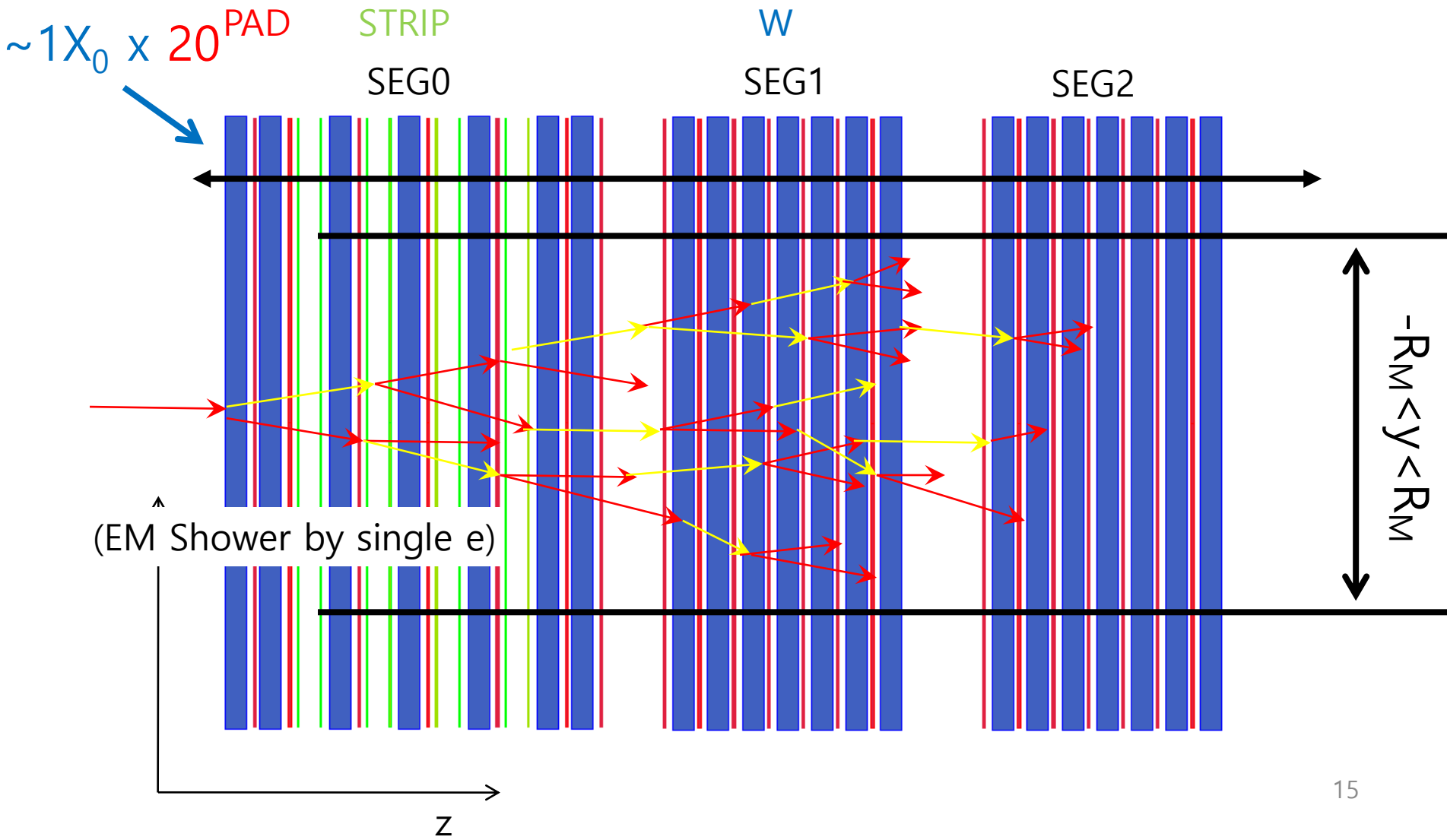




Longitudinal



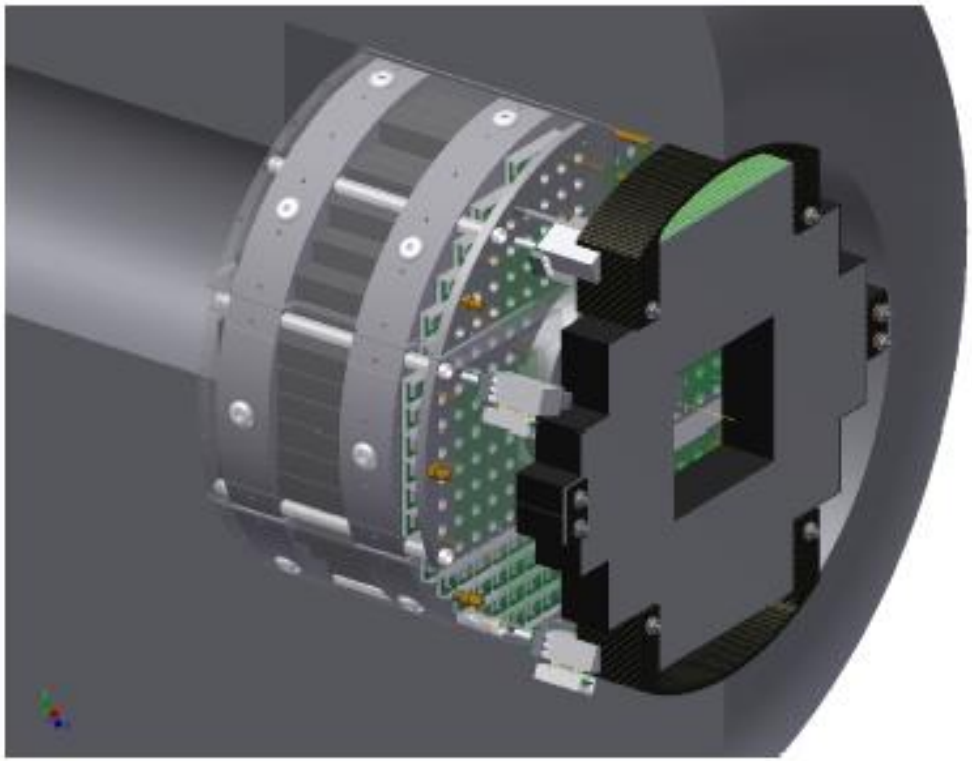
FOCAL - schematic view (y-z view)



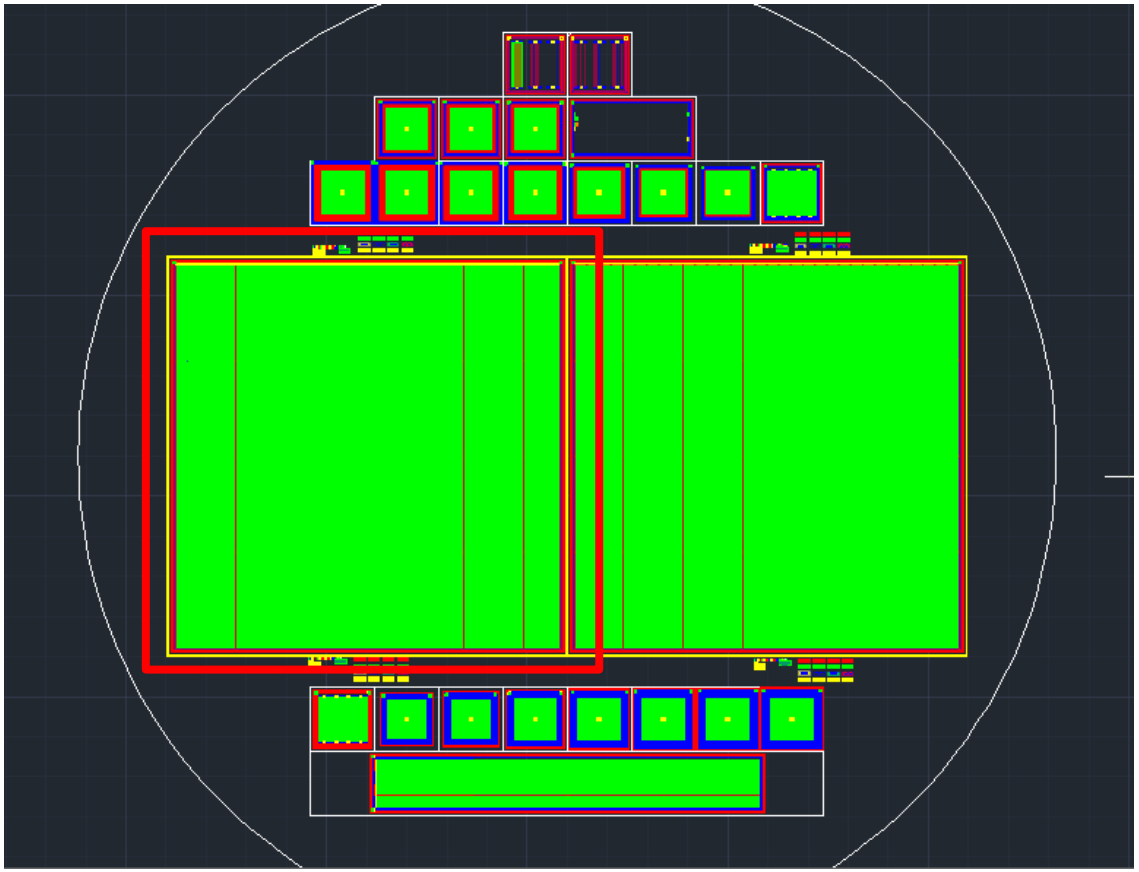
Current snapshot

MPC-EX for PHENIX

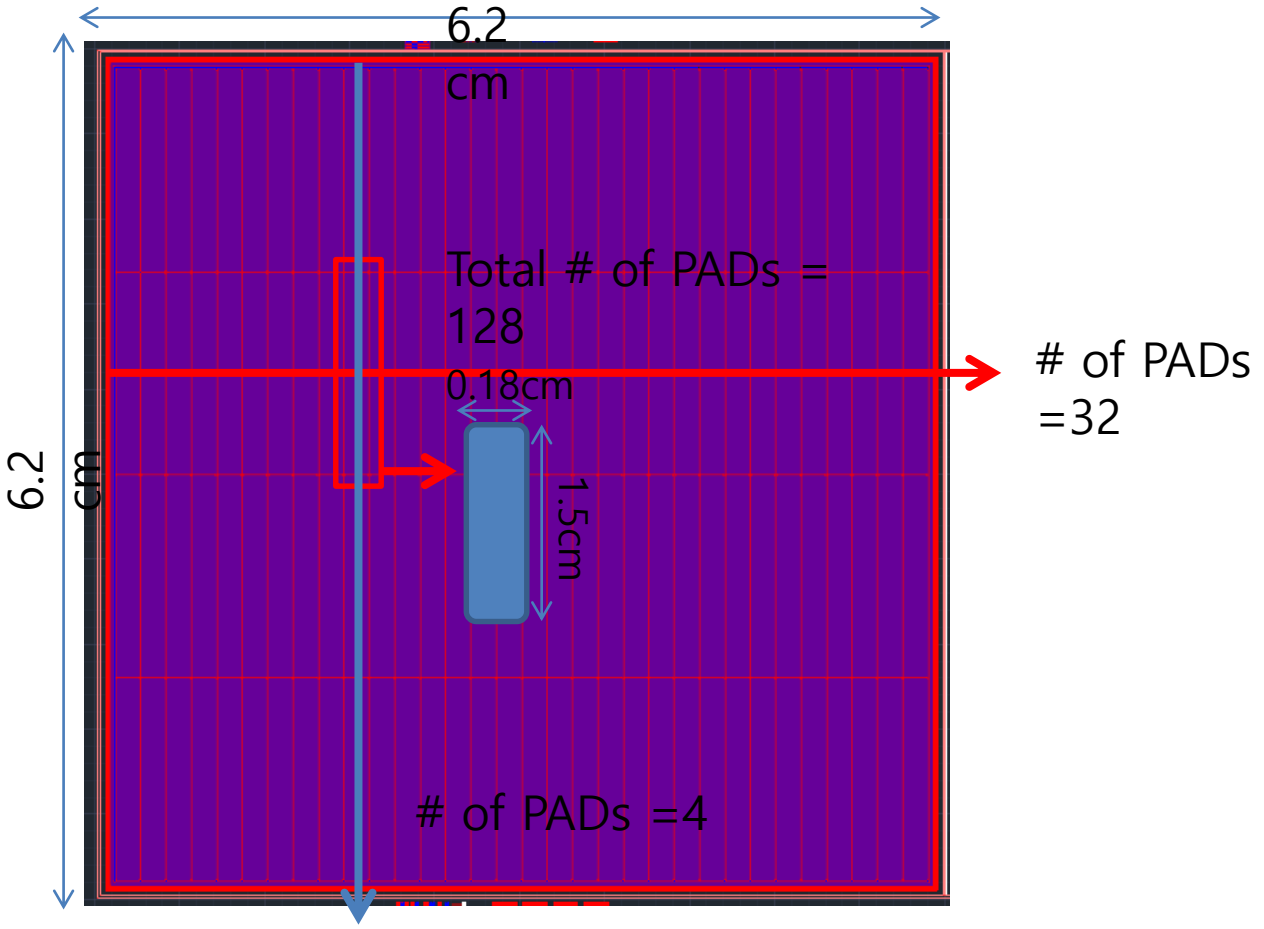
- Application as a pre-shower for EMCal (Electromagnetic calorimeter)



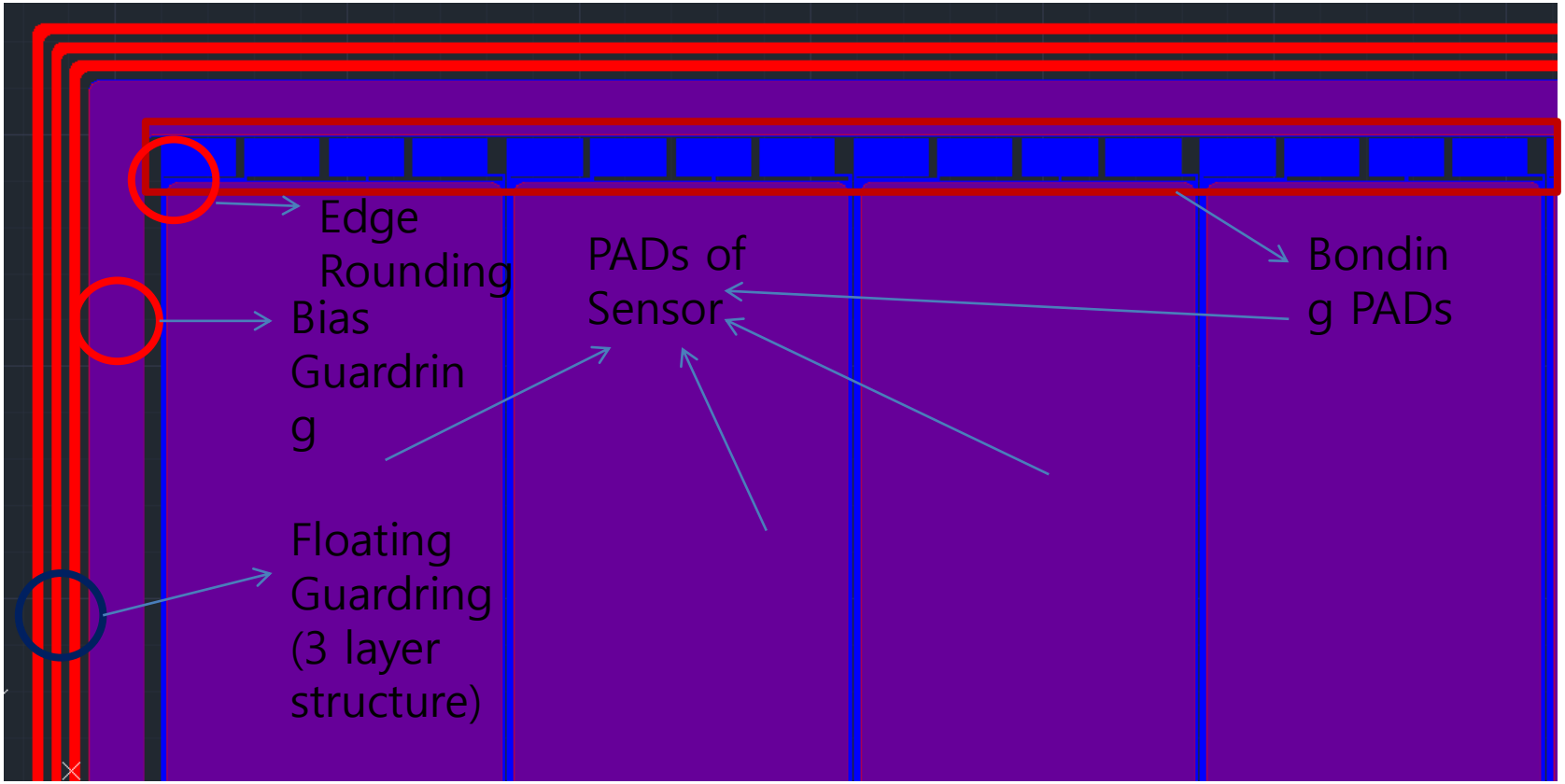
Sensor Design



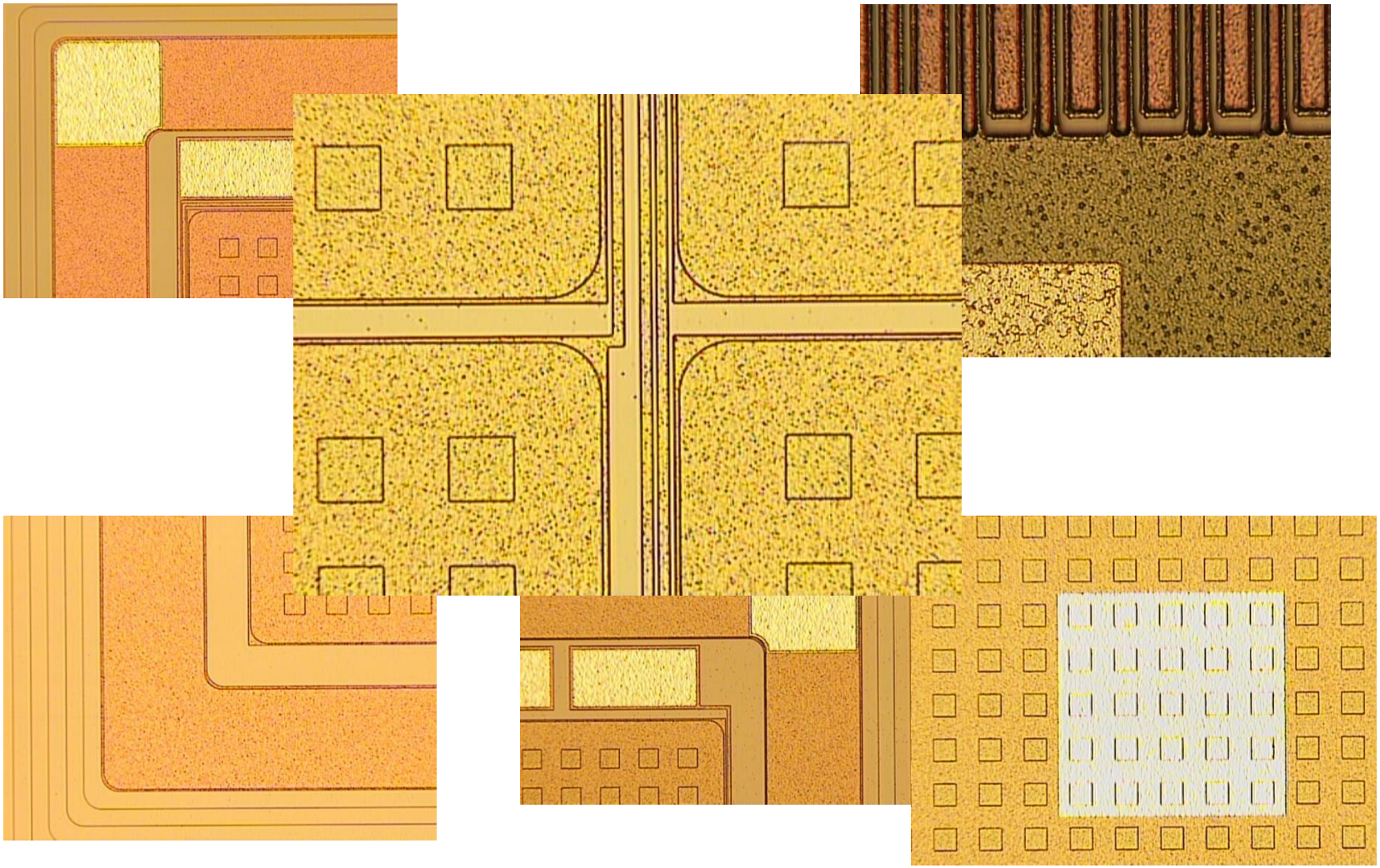
Segmentation as a pre-shower



Fine structure

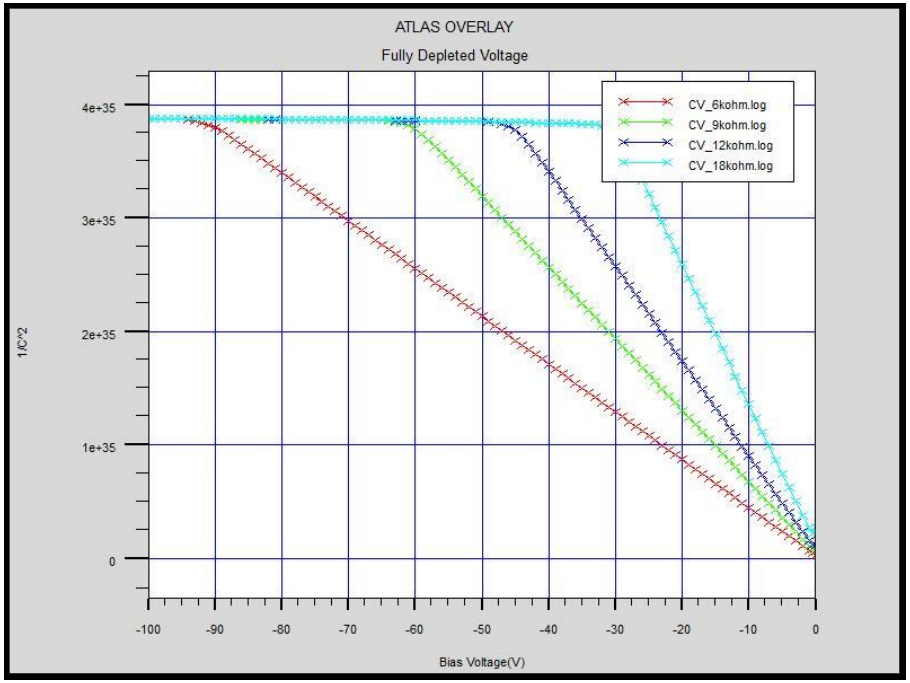


Process monitoring

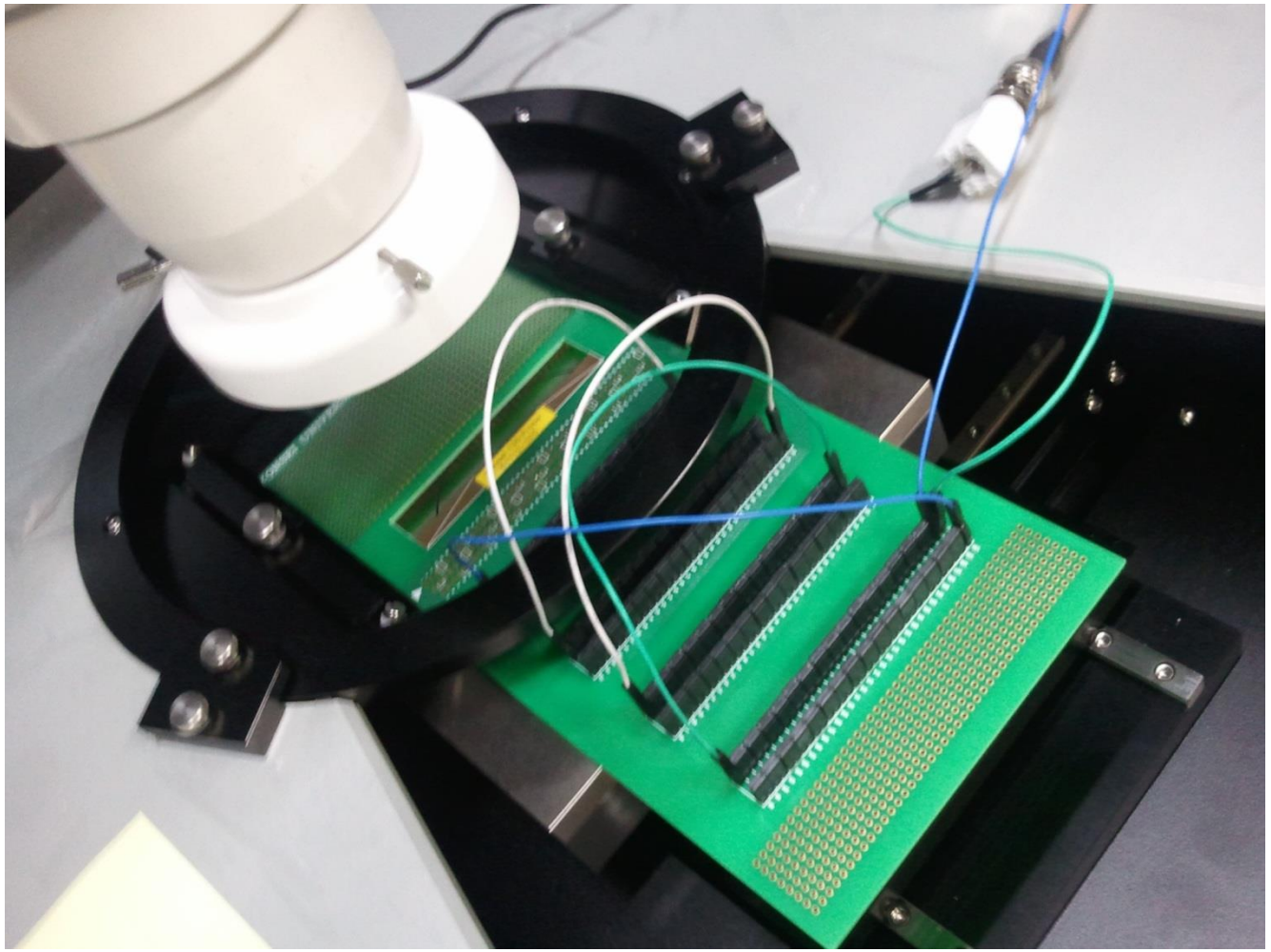


C–V simulation

- Substrate specification
  - ρ(resistivity) = 6,9,12,18 kΩ·cm
  - thickness = 405μm
  - orientation = <100>
- Full depletion
  - 90V(6kΩ·cm)
  - 60V(9kΩ·cm)
  - 45V(12kΩ·cm)
  - 30V(18kΩ·cm)

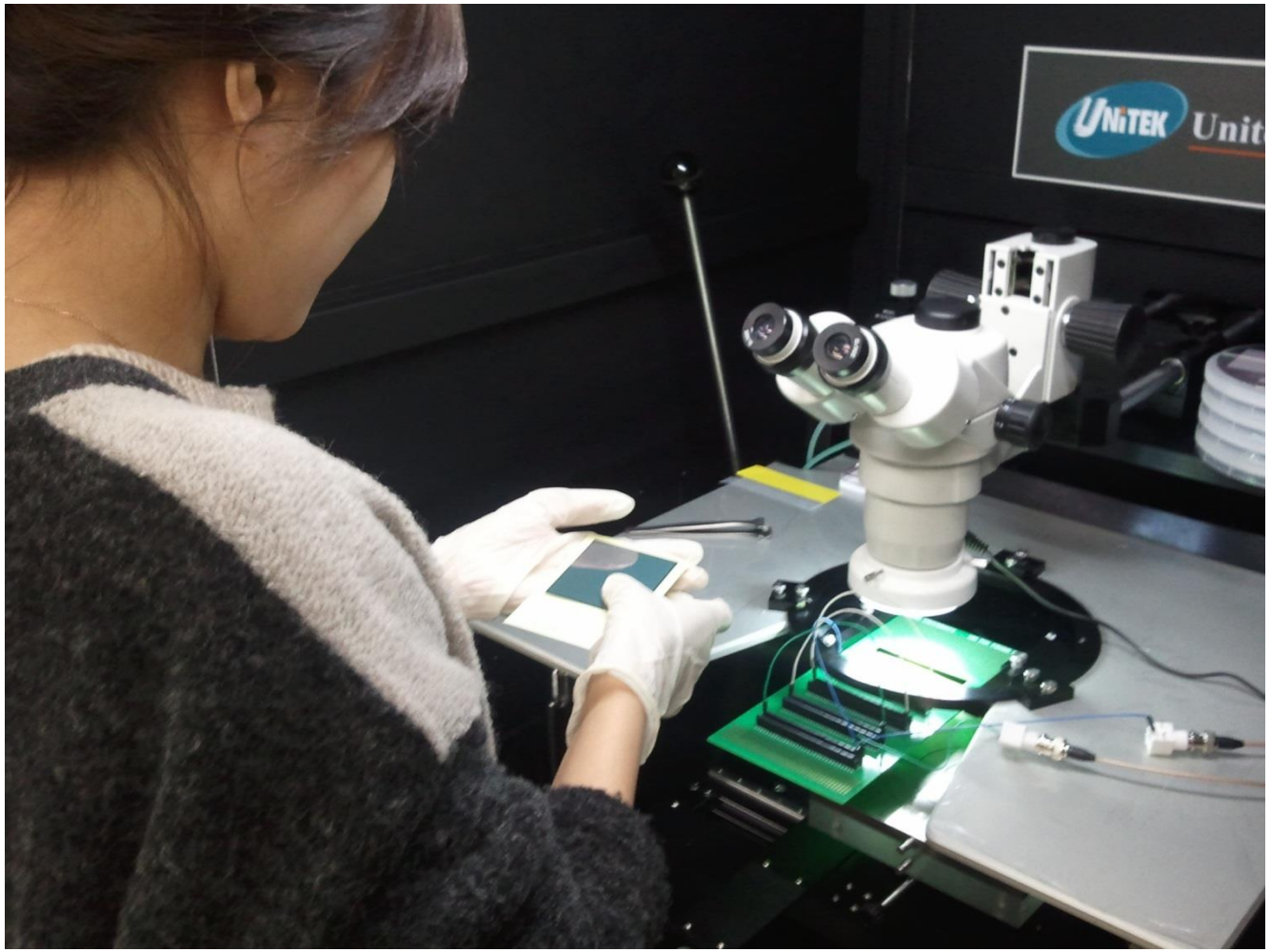


Test system

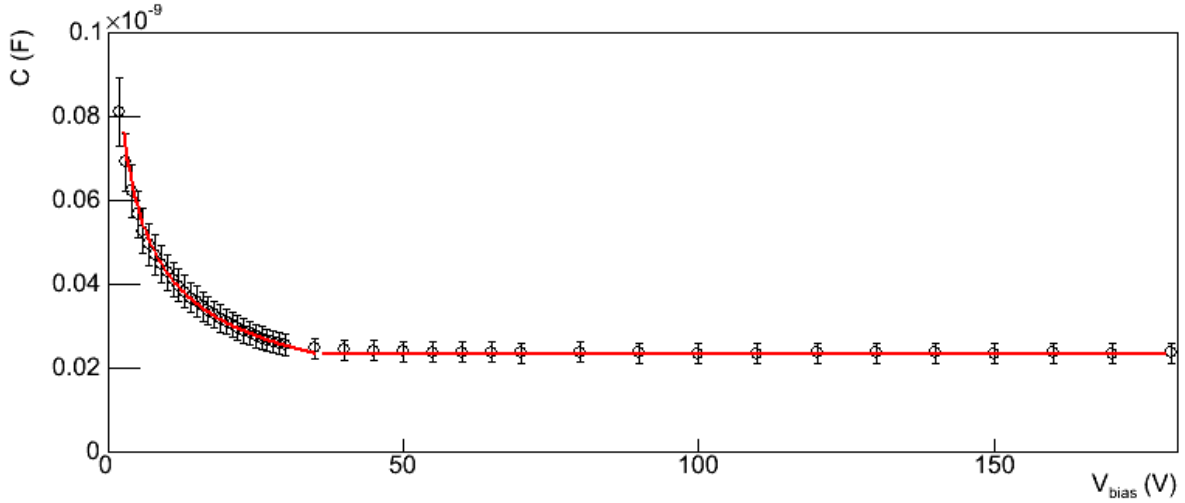


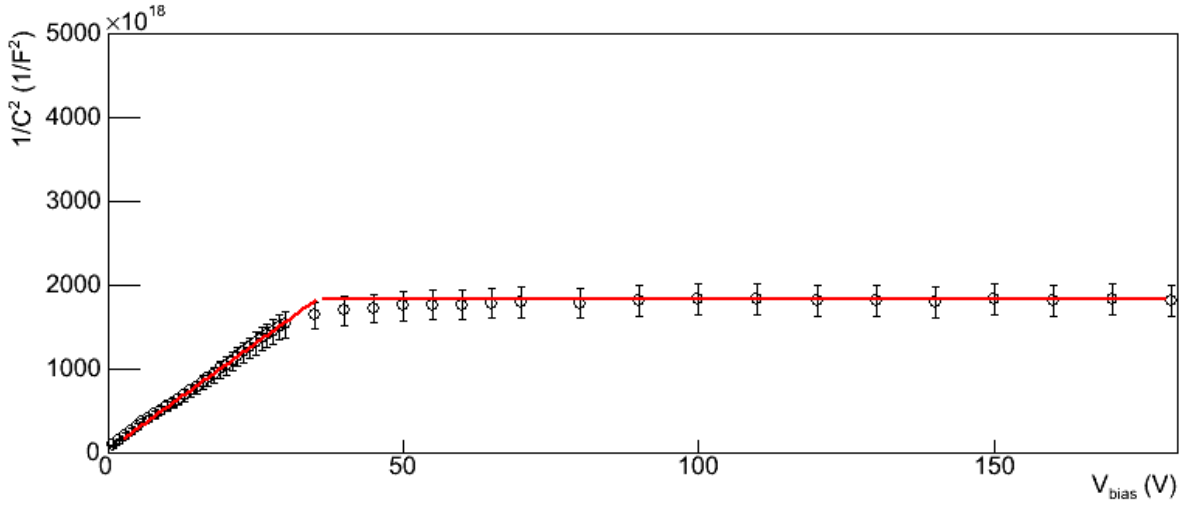
Test electronics

Actual test

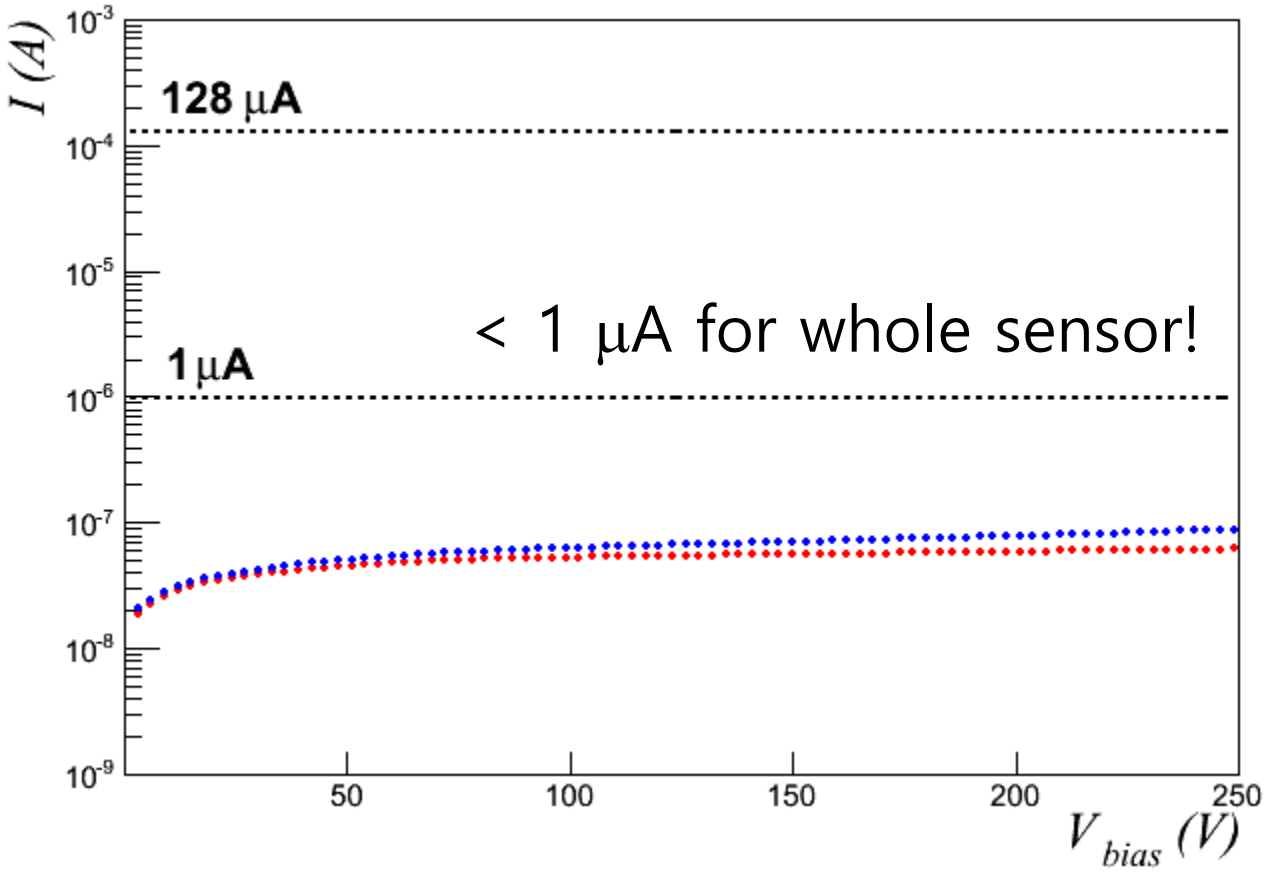


Measurement : Capacitance



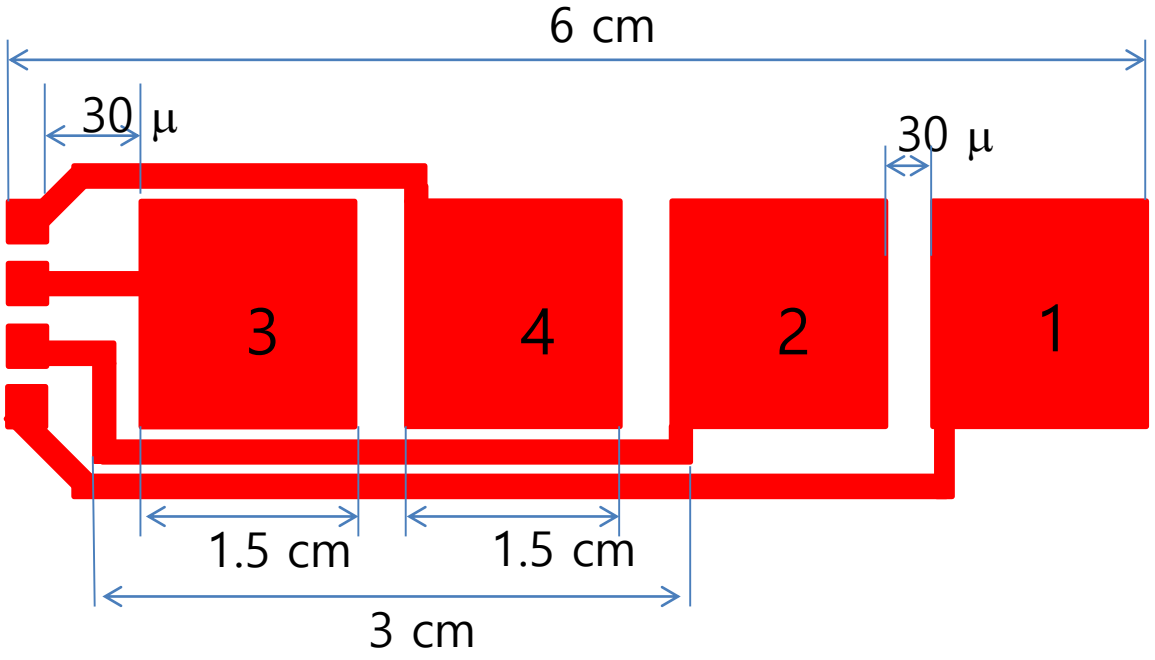


Measurement : Leakage current



Electric circuit test

- We measured resistance between neighboring channels. Small fraction of them had short. Current yield ~ 30%. Statistics sug gest the short is between metal traces. Stringent metal etchin g process is expected to cure the problem.



Ending comment

- Challenges are there…, but bright future is ahead!